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Applicant: Tong Zhang
Appn. Title: Single-Mode Operation and Frequency Conversions for Solid-State Lasers
Examiner: Armando Rodriguez / GAU 2828
Fax: 571-273-1952

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IINFORMATION DISCLOSUIRE STATEMENT
UNDER 37 C.F.R. §1.97 and 1.98

COMMISSIONER FOR PATENTS
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Dear Examiner:

In compliance with the duty of disclosure under 37 C.F.R. §1.56, it is respectfully requested that this Information Disclosure Statement be entered and the reference(s) listed on attached Form PTO- 1449 be considered by the Examiner and made of record.

The present Information Disclosure statement is being filed prior to the receipt of a first Official Action reflecting an examination on the merits and hence is believed to be timely in accordance with 37 C.F.R. § 1.97(b). Accordingly, no fees are believed to be due in connection with the filing of this Information Disclosure Statement.

In accordance with MPEP 1406, a copy of each U.S. patent or U.S. patent application publication listed in an IDS is not enclosed. Following is a concise explanation of the relevance of these references pursuant to Rule 98.

Now there are two portions in the new claims, i.e., claims 1-9 and claims 10-15 in the above reissue patent application. Claim 1 and claim 10 are the two independent claims, respectively. Claims 1-9 are used to cover the situation with respect to a beam expanding laser cavity. Claims 10-15 are used to cover the situation with respect to a regular laser cavity.

In order to overcome the dominant difficulties in the prior art, i.e., the well-known so-called "green problem", two approaches are discovered and specified for obtaining a dynamically

stable single longitudinal mode (SLM) operation with a standing-wave laser cavity. Claim 1 and claim 10 define the first approach and second approach, respectively.

In the first approach of claim 1, a beam expander are applied to render a large modė waist and an improved beam divergence, so as to significantly reduce the insertion losses for intracavity optical elements, typically for a tilted etalon and Brewster plate.

In the second approach of claim 10, a formation of wavelength selectivity with low insertion losses is used in cooperation with a thin gain zone that leads to promoting SLM operation.

The laser arrangement clearly consists of three limitations in claim 10:

(1) a laser gain region is very thin;

(2) the thin gain region is located adjacent to or in contact with an end laser cavity mirror; and

(3) a formation of wavelength selectivity with low insertion losses is placed within a laser cavity, such as a low resolving-power spectral filter, including Lyot filter or low-finesse etalon or the like.

The function of the limitation (1) and (2) in the laser arrangement is to create a circumstance to promote SLM operation. In such a circumstance, all possible longitudinal modes have about an equal chance to extract the available gain. One lucky mode that begins to oscillate first wins the "mode-competition" and deprives the others of the gain needed to oscillate, thereby encouraging or enforcing single-longitudinal-mode operation.

On the other hand, the effect caused by a thin gain region in contact with an end mirror is equivalent to that caused by short cavity configurations, in which longitudinal modes are separated substantially. In such a case, the required resolving-power of a frequency-selective form will be largely relaxed and it becomes possible to use a formation such as a spectral filter with low insertion losses in realizing single-mode operation. A low resolving-power spectral filter would be relative to a low frequency-selective loss. Please also refer to the relevant content about the pre-narrowband approach or the pre-narrowband operation in the parent patent of U.S. Pat. No. 5,515,394.

[Note 1] Regular CW solid-state lasers with intracavity frequency doubling usually exhibit chaotic fluctuations in the visible output. It has been well known and called as the "green problem" since many years ago. In other words, with the use of a regular laser cavity, a visible CW solid-state laser must encounter the "green problem". Such a commercial laser with a solution of the green problem would mainly fall into three categories defined by:

(1) claim 10 above (single mode operation);

(2) Spectra-Physics' patent of U.S. Pat. No. 5,446,749 (multi-axial-mode operation); and

(3) Dr. Thomas Baer's patent of U.S. Pat. No. 5, 627,849 (two or a few mode operation).

And there is almost no other choice. In other words, there are no more categories related to a patentable approach for solving "green problem".

[Note 2] G. J. Kintz and T. Baer in their paper of "Single-Frequency Operation in Solid-State Laser Materials with Short Absorption Depths," IEEE J. QE-**26**(1990)9, 1457, describe an approach as follows:

"The single mode operation can be realized by placing a homogeneously broadened gain medium with a short absorption depth at an end mirror of a cavity. All the longitudinal modes have a common spatial node at the surface of the mirror, and access to the same population inversion since in this narrow excited region. The mode with the highest cross section for stimulated emission will oscillate first, saturation the population inversion and reducing the gain of the medium to the threshold gain of this first mode. This modification of the population inversion reduces the gain available to the other longitudinal modes. Other cavity modes with lower cross sections can not reach threshold since they use the same population distribution as the highest gain mode."

[Note 3] Once again, in claim 10 of the above reissue patent application, a favorable condition for SLM operation is created by means of a thin gain region in contact with an end cavity mirror. Then a low resolving-power spectral filter with low loss, such as birefringent filter or low-finesse etalon or the like, is used to realize single axial-mode CW operation and stable intracavity SHG output, whereby overcoming the major difficulty with intracavity frequency conversions, i.e., the well-known so-called "green problem". Such a laser arrangement is universal for all kind of solid-state lasers.

1. US Patent Application Publication 20070030878 "Laser arrangement and method for the generation of a multimode operation with intracavity frequency doubling", Hollemann; Guenter; (Jena, DE) ; Knoke; Stefan; (Jena, DE). Their disk laser arrangement possesses each of the limitations claimed in claim 10 of the above reissue patent application and such a laser must lead to SLM operation. However, the authors misrepresent their laser operation as "a multimode operation". Their misleading leads others astray and confused in laser physics. Please refer to Note 2 above.

2. Coherent's Sapphire laser is a visible CW solid-state laser with a regular laser cavity. Sapphire laser arrangement extrinsically or inherently possesses each of the limitations claimed in claim 10 of the above reissue patent application.

The same description for the function of the limitation (1) and (2) in the laser arrangement above can be found from those Coherent's patents for their Sapphire laser. In fact, Sapphire's gain medium plays the same function as the regular one under the circumstance of a thin gain region in contact with an end mirror. And the stratified structure of Sapphire's gain medium does not make any special or additional contributions to their laser operation under such a circumstance.

Some of those patents and patent application publication relative to Coherent's Sapphire laser list by the following:

2-1 US Patent Application Publication 20050220165 "High-power external-cavity optically-pumped semiconductor lasers", Caprara, Andrea ; et al. 10-6-2005

2-2 U.S. Pat. No. 6,298,076 "High-power external-cavity optically-pumped semiconductor lasers", Caprara , et al. 10-02-2001

2-3 U.S. Pat. No. 6,438,153 "High-power external-cavity optically-pumped semiconductor lasers", Caprara , et al. 08-20-2002

2-4 U.S. Pat. No. 6,574,255 "High-power external-cavity optically-pumped semiconductor lasers", Caprara , et al. 06-03-2003

2-5 U.S. Pat. No. 6,285,702 "High-power external-cavity optically-pumped semiconductor laser", Caprara , et al. 09-04-2001

2-6 U.S. Pat. No. 6,097,742 "High-power external-cavity optically-pumped semiconductor laser", Caprara et al. 08-01-2000

2-7 U.S. Pat. No. 6,683,901 "High-power external-cavity optically-pumped semiconductor laser", Caprara et al. 01-27-2004

2-8 U.S. Pat. No. 7,180,928 "High-power external-cavity optically-pumped semiconductor laser", Caprara et al. 02-20-2007

2-9 U.S. Pat. No. 6,167,068 "Intracavity frequency-converted optically-pumped semiconductor laser", Caprara , et al. 12-26-2000

2-10 U.S. Pat. No. 6,507,593 "Step-tunable external-cavity surface-emitting semiconductor laser", Spinelli , et al. 01-14-2003

Respectfully submitted,

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Substitute for form 1449A/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	10/820,561
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				First Named Inventor	Tong Zhang
				Art Unit	2881
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Sheet	1	of	1	Attorney Docket Number	

Examiner Initials *	Cite No.[1]	Document Number Number- Kind Code (if known)	Publication Date MM-DD-YY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
U.S. PATENT APPLICATION PUBLICATIONS					
	1	20070030878	2/8/07	Hollemann; Guenter ; et al.	All
	2-1	20050220165	10/6/05	Caprara, Andrea ; et al.	All
U.S. PATENTS					
	2-2	6298076	10/2/01	Caprara , et al.	All
	2-3	6438153	8/20/02	Caprara , et al.	All
	2-4	6574255	6/3/03	Caprara , et al.	All
	2-5	6285702	9/4/01	Caprara , et al.	All
	2-6	6097742	8/1/00	Caprara , et al.	All
	2-7	6683901	1/27/04	Caprara , et al.	All
	2-8	7180928	2/20/07	Caprara , et al.	All
	2-9	6167068	12/26/00	Caprara , et al.	All
	2-10	6507593	1/14/03	Spinelli , et al.	All

Examiner Signature		Date Considered	